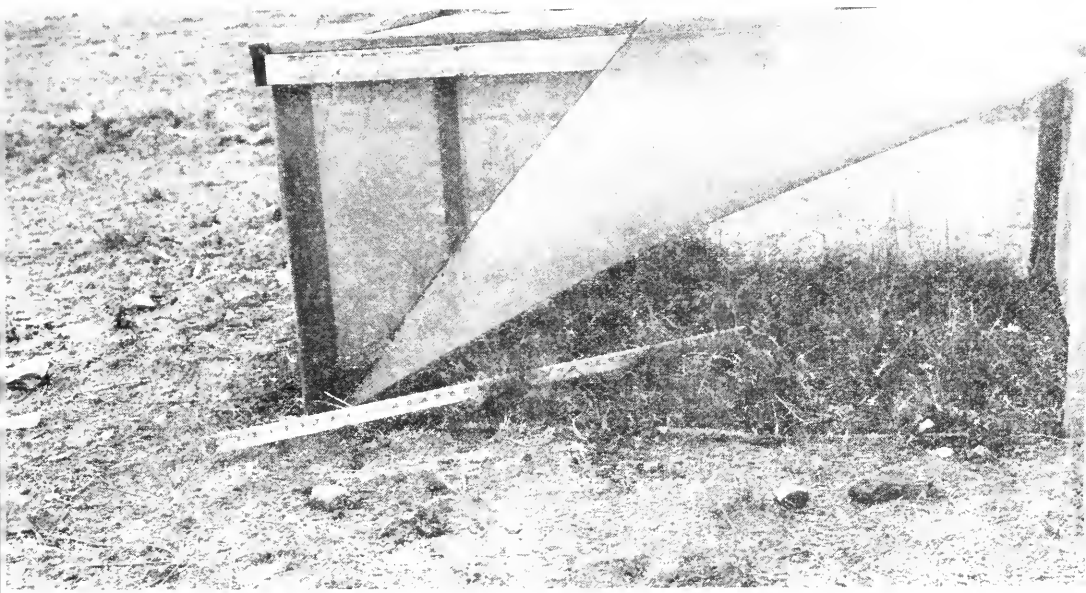
N NO. 333 JANUARY, 1937

# Montana Insect Pests for 1935 and 1936

## The Twenty-Sixth Report of the State Entomologist of Montana

BY

A. L. STRAND, STATE ENTOMOLOGIST



Grasshopper damage to range grasses. The grass beneath the cage was protected from grasshoppers; the grass outside the cage, protected from livestock by a tight fence, was completely destroyed by grasshoppers. (Courtesy of United States Bureau of Entomology and Plant Quarantine.)



MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

# LETTER OF TRANSMITTAL

Bozeman, Montana,
January 1, 1937

To His Excellency,
Governor Roy E. Ayers,
Helena, Montana.

My Dear Sir:

I present herewith the 26th report of the State Entomologist of Montana.

Injurious insects during the biennium just closed were never exceeded in number and variety, we believe, during any like period in the agricultural history of the state. In addition to the continuance of grasshoppers and Mormon crickets as major crop pests, and a recurrence of the pale western cutworm which destroyed several thousand acres of wheat, many other insect species, which were either new as pests in the state, or made their appearance in great numbers after several years of inactivity, attacked various crops with demoniacal fury. The abundance of some of our worst insects is directly related to a lack of precipitation. Dry years are unfavorable to fungus and bacterial parasites which normally keep many of these pests in check. The drought forced more insects onto irrigated lands and it was in the protection of irrigated crops that the greatest saving from insect control work resulted in 1935 and 1936.

One of the chief functions of the State Entomologist in recent years has been to direct within the state insect campaigns supported in part by the federal government. If the proposal now before the congress of the United States, for a permanent fund of five million dollars to be used in emergencies against insects of regional importance, receives favorable action, even more extensive duties will fall upon this office.

We wish to call your attention particularly to the problem of grasshopper damage to range grasses as presented in this report and to the need for greater state support for research and control work in order to gain the fullest advantage from federal funds appropriated for the control of our major insect pests.

Respectfully yours,

A. L. STRAND,
State Entomologist

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# Twenty-Sixth Report of the State Entomologist

## THE CONTROL OF INSECT PESTS IN MONTANA

Next to dry weather and the lack of irrigation water, insects constitute the greatest hazard to the production of agricultural crops in Montana. The control of insect pests is most economically accomplished when there is close accord between control activities and the research work which may be in progress on the insects involved. A library containing the voluminous standard works on entomology as well as the current scientific literature is required. A collection of insects, named, catalogued, and as nearly as possible giving complete coverage of the state both as to uncommon and economic species, is likewise an essential. In other words, the suppression of insect pests must be based on all available information and constantly improved by investigation. For these reasons the law creating the Office of State Entomologist, passed in 1903, designated the entomologist of Montana State College and Agricultural Experiment Station as the State Entomologist. By so doing needless duplication and unnecessary expense were avoided and at the same time the best possible service to the agricultural interests of the state was assured.

The State Entomologist, as evident therefore, has his regular duties in the College and Experiment Station. No part of his salary comes from the State Entomologist Fund.* His duty is to direct the insect control work which, as shown above, is intimately tied up with the investigation of insects. Consequently he must have the necessary assistants to properly carry out the objectives of the State Entomologist law. In years past the appropriations for this work have at times been too small to employ any help whatever and the work has suffered accordingly. The twenty-fourth session of the Montana Legislature increased the appropriation sufficiently to allow the em-

*The work of the State Entomologist should not be confused with that of the State Board of Entomology. Appropriations to the State Entomologist Fund are used for the suppression of insect pests of agricultural crops. The Board of Entomology is concerned with ticks and insects responsible for the transmission of various diseases to man and animals.

ployment of one full-time assistant, Dr. H. B. Mills, who has served as Assistant State Entomologist since July 1, 1935.

The State Entomologist cooperates closely with the Montana Agricultural Extension Service, carrying out much of his work through the county agents. The two agencies have shared with the United States Department of Agriculture the expense of the annual grasshopper survey, the accumulation of data on which has resulted in obtaining much needed federal aid on the control of migratory insects, and all phases of the general problem of insect control. The Agricultural Extension Service does not employ an entomologist, which function is delegated to the State Entomologist.

In the following pages will be found brief discussions of the most important insect problems in Montana during the past two years, the financial saving which has been made through insect control, and a statement of the needs and plans for future work.

## GRASSHOPPERS ON CULTIVATED LANDS IN 1935

Severe losses from grasshoppers occurred in 1935. Whereas in 1934 the heaviest infestations were found on nonirrigated lands in northern and north-central Montana, during 1935 the severe infestations were on or near irrigated land along the Yellowstone river. This shift in grasshopper populations was not indicated by the egg survey in the fall of 1934. Park and Sweetgrass counties were properly warned of the impending danger, but the estimates for Stillwater, Yellowstone, Treasure, Big Horn, Rosebud, and Custer counties were entirely too low and gave the farmers a feeling of false security. This undue faith in the survey prediction was unfortunately strengthened by the delayed hatching of the grasshoppers. Until late June and early July little hatching had taken place and farmers, who looked over their fields up to that time, could see little evidence of the trouble which was coming. It had been estimated that about 331 tons of poisoned bait would be needed in the eight counties noted above; actually over 600 tons were used, or over a third of the total for the entire state. See table 6.

Even though poisoning operations were delayed, thousands of acres of irrigated crops were saved by strenuous campaigns beginning about the first week in July. Through the coopera-

tion of the Agricultural Extension Service and this office, twenty-one cars of federal bait were shipped into the Yellowstone Valley in addition to several cars of new bran and arsenic laid down there early in the season, in exchange for an equal amount of bait shipped from eastern Montana points into North Dakota. Freight on the July shipments was paid by the counties but as a special tariff on grasshopper bait and bait materials had been obtained early in the season, the actual cost per ton of bait received was very low.

### GRASSHOPPERS IN RELATION TO CULTIVATED CROPS IN 1936

Thirty-six counties engaged in grasshopper control in 1936. Each of fifteen counties used more than 50 tons of poisoned bait, dry basis, and nine used a total of 100 tons each or more. One county, Yellowstone, put out 754 tons. Altogether, farmers, county agents, and county commissioners feel that the campaign was one of the most successful ever carried out in the state although it did not approach in extent and intensity the control work on grasshoppers done in 1934. As will be seen from table 1, over 3,000 tons of dry bait were distributed or enough to give one treatment to 600,000 acres. The actual amount used by farmers in protecting crops on cultivated land was probably more than is indicated by the record given. Much of the sawdust used in diluting the usual bait ingredients was unaccounted for and many tons of old bait stored on farms came into use without appearing in county totals. The total bait distributed was probably close to 3,800 tons.

The chief sources of bait were from county and private funds and from the supply of old federal bait left over from the previous two years. The Works Progress Administration furnished 328 tons of bran in 14 counties. The remainder, or 402.5 tons came from a special appropriation passed by congress in the latter part of June and administered by the United States Bureau of Entomology and Plant Quarantine. The new federal bait and WPA supplies came late in the season so the above figures do not represent the total amounts received from those sources but only the amounts used. Of the 840 tons of bran in storage for the expected 1937 outbreak of grasshoppers, a large part came from WPA and 97.5 tons from the direct

TABLE 1.—GRASSHOPPER BAIT USED IN MONTANA IN 1936

| County | Old fed. bait | New fed. bait | WPA bait | County and private bait | Total |
|---|---|---|---|---|---|
| | Tons | Tons | Tons | Tons | Tons |
| Beaverhead | — | — | — | 25.5 | 25.5 |
| Big Horn | 5.0 | 40.0 | 43.0 | 100.0 | 188.0 |
| Blaine | 15.0 | — | — | — | 15.0 |
| Carbon | — | 20.0 | 20.0 | 200.0 | 240.0 |
| Cascade | 100.0 | — | — | — | 100.0 |
| Chouteau | 20.0 | — | — | — | 20.0 |
| Custer—Powder River | 24.0 | — | — | — | 24.0 |
| Daniels | 2.0 | — | — | — | 2.0 |
| Dawson | 4.0 | — | — | — | 4.0 |
| Fallon-Carter | .8 | — | — | — | .8 |
| Fergus | 70.0 | — | — | 10.0 | 80.0 |
| Flathead | — | — | — | 0.15 | 0.15 |
| Gallatin | 20.0 | 20.0 | 20.0 | 24.0 | 84.0 |
| Garfield-Petroleum | 5.0 | — | 15.0 | 5.0 | 25.0 |
| Glacier | 20.0 | — | — | — | 20.0 |
| Hill | 26.0 | — | — | — | 26.0 |
| Judith Basin | 30.0 | — | 5.0 | — | 35.0 |
| Lake | 1.4 | — | — | — | 1.4 |
| Lewis and Clark—Broadwater | 17.0 | — | — | 7.9 | 24.9 |
| Madison—Jefferson | 45.0 | — | — | 12.0 | 57.0 |
| Missoula | — | — | — | .1 | .1 |
| Musselshell—Golden Valley— | 0.3 | 20.0 | 5.0 | — | 25.3 |
| Park | 8.0 | — | 24.0 | 14.5 | 46.5 |
| Phillips | 20.0 | — | 3.0 | 2.5 | 25.5 |
| Pondera | 156.0 | — | 10.0 | 1.5 | 167.5 |
| Prairie | 7.0 | — | — | — | 7.0 |
| Richland | 30.0 | — | — | — | 30.0 |
| Roosevelt | 40.0 | 37.0 | — | — | 77.0 |
| Rosebud | 45.0 | 20.0 | 30.0 | 25.0 | 120.0 |
| Sanders | 3.5 | — | — | — | 3.5 |
| Sheridan | 60.0 | — | — | 5.0 | 65.0 |
| Stillwater | 10.0 | 6.5 | 18.0 | 25.5 | 60.0 |
| Sweet Grass | 6.0 | 80.0 | 80.0 | 214.0 | 380.0 |
| Teton | 130.0 | 20.0 | 40.0 | — | 190.0 |
| Toole | 100.0 | — | — | — | 100.0 |
| Valley | 14.5 | — | — | — | 14.5 |
| Wheatland | — | — | 15.0 | — | 15.0 |
| Wibaux | — | 10.0 | — | — | 10.0 |
| Yellowstone | — | 129.0 | — | 625.0 | 754.0 |
| Totals | 1035.5 | 402.5 | 328.0 | 1297.65 | *3063.65 |

*Estimates on sawdust used (750 tons) bring this total up to 3813.65 tons dry bait used for 1936.

federal appropriation. The remainder is bran purchased by counties under the insect pest law. See table 2.

A very great part of all the poisoned bait used in 1936 went to protect irrigated crops. In many localities over the state but particularly in the Yellowstone Valley large acreages would have been completely destroyed by grasshoppers had it not been for the intensive control programs which were organized against them.

TABLE 2.—GRASSHOPPER BAIT AND BAIT MATERIALS ON HAND

| County | Mixed bait | Bran | Sodium arsenite* | Crude arsenic | Molasses |
|---|---|---|---|---|---|
| | Tons | Tons | Gallons | Pounds | Gallons |
| Beaverhead | — | 22.5 | 400 | — | — |
| Big Horn | 2.0 | 50.0 | 300 | 2000 | — |
| Blaine | — | 20.0 | — | 500 | — |
| Carbon | — | 60.0 | 44 | — | — |
| Cascade | — | — | 500 | — | — |
| Chouteau | — | 20.0 | — | 2800 | 5 |
| Custer—Powder River | 1.0 | 60.0 | — | 775 | 275 |
| Daniels | 11.0 | — | — | 2700 | — |
| Dawson | 36.0 | — | — | — | — |
| Fallon—Carter | — | — | — | — | — |
| Fergus | 5.0 | 75.0 | 350 | 2000 | 200 |
| Flathead | 5.0 | — | — | — | — |
| Gallatin | — | 30.0 | 125 | 150 | — |
| Garfield—Petroleum | — | 20.0 | 200 | — | 50 |
| Glacier | 8.0 | — | — | 2000 | 1000 |
| Hill | 15.0 | 15.0 | — | 19000 | — |
| Judith Basin | 15.0 | 15.0 | — | 1200 | — |
| Lake | — | — | — | — | — |
| Lewis and Clark—Broadwater | 3.0 | — | — | 2100 | — |
| Madison—Jefferson | 22.0 | — | 220 | 800 | 25 |
| Missoula | — | — | — | — | — |
| Musselshell—Golden Valley | — | 15.0 | — | 800 | 150 |
| Park | — | 55.0 | 50 | — | — |
| Phillips | 10.0 | 57.0 | — | 500 | — |
| Pondera | 65.0 | 42.0 | — | — | — |
| Prairie | 15.5 | — | — | — | — |
| Richland | 30.0 | 60.0 | 200 | 1500 | — |
| Roosevelt | 3.0 | — | — | 2500 | — |
| Rosebud | — | 15.0 | 200 | — | 1000 |
| Sanders | 20.5 | — | — | 600 | — |
| Sheridan | 5.0 | 60.0 | — | — | — |
| Stillwater | — | 26.0 | 200 | 500 | — |
| Sweet Grass | — | 18.0 | — | — | — |
| Teton | 12.0 | 22.0 | 300 | 8000 | — |
| Toole | 40.0 | — | — | 6000 | — |
| Valley | 25.5 | — | — | — | — |
| Wheatland | — | 45.0 | 200 | 1200 | — |
| Wibaux | 30.0 | — | — | — | — |
| Yellowstone | 20.0 | 37.5 | 200 | 1272 | — |
| Totals | 399.5 | 840.0 | 3489 | 58,897 | 2805 |

*Liquid sodium arsenite on basis of "4 lb. material"

## GRASSHOPPERS IN RELATION TO THE RANGE, 1934-1936

The most serious insect problem in Montana at the present time is to find and demonstrate a way of preventing the destruction of range forage plants by grasshoppers. This damage was severe in 1934 but has become even worse the past two seasons. In those three years the total loss on the range has been set at $1,750,000. (See table 4). This figure is probably far too low; it is based on an estimated damage of approximately 16 to

20 per cent of the range in central and eastern Montana and a value of 10 cents per acre for the grass destroyed.

Drought has been, of course, an important factor in the depletion of the range, but any doubt concerning the part that is played by grasshoppers can be dispelled by an examination of the picture on the cover page of this report. Grass developed in spite of the drought but was eaten down to the ground by hordes of grasshoppers. If we should include the financial losses incident to the forced movement or sale of livestock directly connected with grasshopper damage to range grasses, to say nothing of the loss to cultivated crops by the migrations into them of range species, the total loss encountered would be at least twice that indicated above, or approximately $3,500,000. When we consider that the direction of our agricultural development has turned strongly toward the improvement and better use of our grazing resources, this problem assumes no small importance as a factor contributing to the future prosperity of the state.

The problem is not a new one; it has just presented itself in a new light. When we are successful in preventing by means of poisoned bait about one-half the loss that would otherwise occur to our cultivated crops, (actually we could do far better) it seems almost absurd that nothing so far has been done to prevent at least a part of the heavy losses to our range. In the late 1870's and early 80's, again from 1900 to 1904, and to a lesser extent in the early 1920's grasshoppers did tremendous damage to our grass lands. In the past, with the return of years of greater precipitation, the grass revived while at the same time conditions were unfavorable to grasshopper development and they deceased to unimportant numbers. The same will no doubt happen again if we do nothing at all. But why should we take that viewpoint in regard to the range and not in regard to other valuable crops? The reason is that it has never been demonstrated in this country that range grasshoppers can be controlled on a sound economic basis.

There are two possible approaches to the solution of the problem: (1) Await the return of years of higher precipitation with conditions unfavorable to grasshopper development. When natural causes have depleted their numbers then keep them down by the diligent use of poison in areas where outbreaks

seem to make their start. (2) By use of a less expensive poisoned bait during the development of an outbreak and even at its height.

### The Prevention Idea in Range Grasshopper Control

There is much to be said in favor of this method but also a few adverse points to consider in its possible application to Montana conditions. The most economic way of handling all insect-control problems is to apply the remedy, whatever it may be, before the insects have reached the outbreak stage. That is the cheapest and in many cases the only feasible line of attack. This approach to the range-grasshopper problem has been tried and proved successful in British Columbia where very extensive range areas are under the control of relatively few individuals. There the warrior grasshopper is the dominant species. This 'hopper has two rather conspicuous characteristics. It is very

TABLE 3.—TOTAL NUMBER OF GRASSHOPPERS BY SPECIES AND FREQUENCY OF OCCURRENCE ON RANGE AND IN CROP SUMMARIZED FROM 30 COLLECTIONS, JULY, 1936

| Scientific name | Common name if any | Total collected | | Frequency of occurrence | |
|---|---|---|---|---|---|
| | | Range | Crop | Range | Crop |
| Melanoplus mexicanus | Lesser Migratory | 336 | 430 | 16 | 12 |
| Melanoplus bivittatus | Two-striped | 1 | 18 | 1 | 6 |
| Melanoplus packardi | Packard's | 59 | 35 | 14 | 7 |
| Melanoplus occidentalis | ——— | 11 | 4 | 3 | 2 |
| Melanoplus infantalis | ——— | 107 | 7 | 15 | 3 |
| Melanoplus confusus | ——— | 2 | 0 | 2 | 0 |
| Melanoplus femur-rubrum | Red-Legged | 5 | 0 | 3 | 1 |
| Melanoplus bowditchi | ——— | 1 | 0 | 1 | 0 |
| Camnula pellucida | Warrior | 63 | 172 | 9 | 5 |
| Dissosteira carolina | Carolina | 10 | 6 | 5 | 4 |
| Aulocara elliotti | Big-Headed | 440 | 178 | 19 | 9 |
| Metator pardalinus | ——— | 25 | 15 | 8 | 7 |
| Aeoloplus turnbulli | ——— | 72 | 15 | 7 | 5 |
| Orphuella pelidna | ——— | 0 | 1 | 0 | 1 |
| Hadrotettix trifasciatus | ——— | 4 | 1 | 3 | 1 |
| Ageneotettix deorum | ——— | 165 | 9 | 16 | 2 |
| Bruneria brunnea | ——— | 2 | 6 | 2 | 1 |
| Derotmema haydeni | ——— | 8 | 6 | 4 | 1 |
| Amphitornus coloradus | ——— | 35 | 4 | 7 | 2 |
| Cordillacris crenulata | ——— | 24 | 0 | 6 | 0 |
| Trachyrhachis kiowa | ——— | 27 | 1 | 12 | 1 |
| Hesperotettix viridis | ——— | 9 | 0 | 4 | 0 |
| Aeropedellus clavatus | ——— | 4 | 0 | 1 | 0 |
| Drepanopterna femoratum | ——— | 19 | 0 | 4 | 0 |
| Trimerotropis campestris | ——— | 5 | 0 | 3 | 0 |
| Trimerotropis laticincta | ——— | 0 | 3 | 0 | 1 |
| Trimerotropis agrestis | ——— | 0 | 1 | 0 | 1 |
| Cordillacris occipitalis | ——— | 2 | 0 | 2 | 0 |

easy to poison, and it lays its eggs in very definite types of terrain so that in the spring the young 'hoppers are concentrated in relatively small areas. The importance of these two things can be readily appreciated in any program where the object is the prevention of outbreaks.

Now in Montana there is more than one important species on our range; in fact a dozen different species must be considered and at least three or four are of primary concern. Last summer thirty different collections of grasshoppers were made through central, north-central, and eastern Montana with the idea of showing the relative distribution of species on the range and in near-by crops. The results are shown in table 3. These collections were made in July before the great seasonal dispersion and migration of grasshoppers took place. It will be seen that out of the twenty-five different kinds of grasshoppers collected on range land, five or six were not only very abundant but were taken in many different places. The most important ones are the Big-headed grasshopper *(Aulocara elliotti)* and the Lesser Migratory grasshopper *(Melanoplus mexicanus)*. These are surely the dominant ones and are shown in figures 1 and 2. At different times and in different places several other species would doubtless be important factors in range destruction. Possibly the Warrior grasshopper *(Camnula pellucida)* should rank third over the state in general, although superceded in these particular collections by two other species. With such a ranking the three important range grasshoppers are also very important to cultivated crops, although they are not the only ones.

In relation to these data it is worth while to note that R. A. Cooley in the First Report of the State Entomologist, December, 1903, wrote as follows:

> In our various trips into the worst affected regions we found a fairly uniform state of affairs throughout. On the range two or three species, taken together, constitute a large proportion of the total number, though in restricted localities one or another species besides these was more abundant. The three most common species on the range were the Big-headed locust *(Aulocara elliotti)*, the Lesser Migratory locust *(Melanoplus atlanis)*, and the Yellow-winged or Warrior locust *(Camnula pellucida)*. In point of abundance the Big-headed grasshopper was the leading species of the three. The Lesser-Migratory locust was second in importance. It prefers the drier uplands to the irrigated valleys, but in many cases it was found in great abundance in grain fields, particularly on the benches and in non-irrigated

fields. The Yellow-winged, or Warrior, locust is more local in its distribution, often occurring in immense numbers in restricted localities and at times becoming very injurious to grasses and grains.

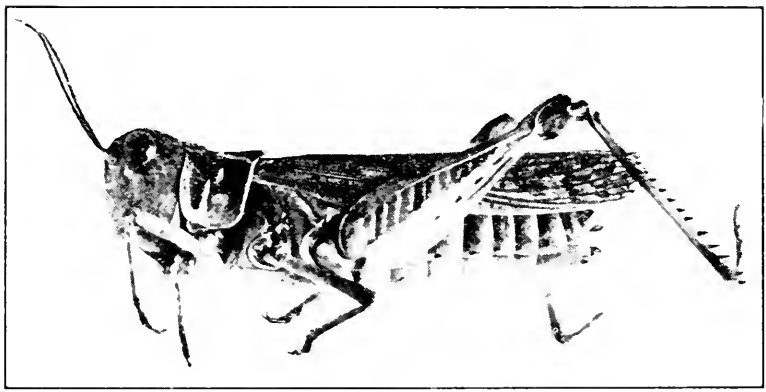

Figure 1.—The big-headed grasshopper *(Aulocara elliotti)*, the dominant species on the range in Montana.

It will be seen by comparing Professor Cooley's remarks with table 3 that conditions today are much the same as in 1903. We have now and probably always have had a more complicated situation on our range than apparently obtains at the present time in British Columbia. It should be remembered as well that our range has been the breeding ground from whence have come some of the great historical grasshopper outbreaks. It made up a large part of the primary breeding territory of the notorious Rocky Mountain Migratory locust which laid waste a large part of the middle west some sixty years ago. We are forced to assume that for generations past this territory has been very favorable at times, and not infrequently, to the development of grasshoppers which in number and variety have been equalled by few other areas in the world.

In order to successfully prosecute a program built around the idea of the *prevention of grasshopper outbreaks on the range* the following factors important and necessary thereto may be summarized as follows:

1. The program would have to include cultivated land as

well as range land since the two most important species on the range are also very important on cultivated lands.

2. The program would prove difficult in proportion to the degree in which various range species scatter their egg pods. The Lesser Migratory grasshopper and many other kinds do not concentrate their egg pods as does the Warrior.

3. Almost an ideal spirit of cooperation would be required among many different groups: ranchers, farmers, governmental agencies such as the Forest Service, the Indian Service, the Taylor Grazing Units, the Resettlement Administration, the state and counties in relation to lands under their permanent or temporary control, nonresident land owners, etc.

4. Some kind of a governmental subsidy to make the program work for not the least difficulty would be in getting grasshoppers poisoned at the times when range or crop damage was not imminent.

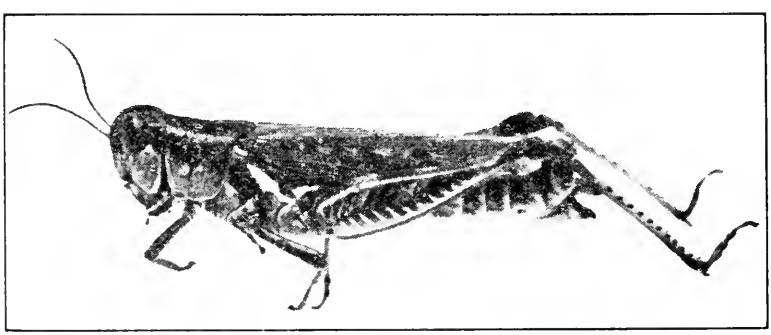

Figure 2.—The lesser-migratory grasshopper *(Melanoplus mexicanus)*, the second most important species on the range and the most destructive species to cultivated crops in Montana.

5. The organization of the control work to cover over 30,000,000 acres of range land in central and eastern Montana and 20,000,000 acres in farms. In addition excellent cooperation with other states and the Dominion of Canada would be required on account of the migration of various species of grasshoppers at least during the height of an outbreak.

6. A broader and more intensive program of grasshopper research than is being supported at the present time.*

**Direct Offensive Against Range Grasshoppers**

According to this method of approach we would attempt the control of range grasshoppers by an extensive campaign of poisoning on the range. During the worst years five million acres or more would have to be treated, although there are times even in great outbreak years when the 'hoppers seem to congregate in low places where the feed is greener, making it possible to get considerable control by treating a smaller percentage of the entire area. With our present bait formula, a straight poisoning campaign, in which a large part of affected range would be treated, does not appear to be economically sound. The cost of bait alone would be about 10 cents per acre which is about the rent value of the grass saved on good range if perfect control were obtained. Let us look for a moment at the economics of poisoning just one-sixth of the range land east of the continental divide in Montana. This woud be approximately five million acres. Provided the bait could be cheapened to half the cost of that now in general use the expense would be $312,500. As there is probably not man power on our ranches sufficient to take care of the spreading of 25,000 tons of bait, the cost of distribution would enter into the total cost of the operation. There are three possible ways by which the bait could be distributed: by hand from light trucks or buckboards, by mechanical spreaders, or by airplanes. Accordingly, the cost for one application of poisoned bait to five million acres, counting one dollar an hour for hand spreading (two men), one and one-half dollars per hour for the operation of a mechanical

*The Montana Agricultural Experiment Station is no longer engaged in investigation of grasshoppers. In 1930 when the laboratory of the U. S. Bureau of Entomology and Plant Quarantine was established on the campus at Montana State College with Dr. J. R. Parker (formerly with the Montana Agricultural Experiment Station) in charge, an agreement was entered into under which research work on grasshoppers is to be done by the federal laboratory and the control of grasshoppers by the State Entomologist's office.

spreader, and twelve dollars per hour for an airplane, would be about as follows:

| Method of spreading | Rate acres per hour | Labor time hours | Cost of spreading | Cost of bait | Total cost |
|---|---|---|---|---|---|
| Hand | 8 | $625,000 | $625,000 | $312,500 | $937,500 |
| Mech. Spreader | 25 | 200,000 | 300,000 | 312,500 | 512,500 |
| Airplane | 100 | 50,000 | 600,000 | 312,500 | 912,500 |

It is extremely doubtful if enough airplanes to do the job within a reasonable length of time could be found in the country. Furthermore even at twelve dollars per hour, which is a very low rate for airplane hire, the cost is excessive. The airplane method is all very well for dusting a few acres of high-priced crops in California, but for grasshopper control it appears very impractical. Even more impossible and expensive would be hand spreading. On the contrary the use of mechanical spreaders, made from the rear ends of old automobiles, is within the bounds of reason. Two thousand such mechanical spreaders could be built and still keep the total cost below $600,000. This estimate contains two presumptions which may be unwarranted. First, that the cost of the bait could be reduced to $12.50 per ton, and second, that enough materials would be obtainable for the work.

Between the two approaches to the control of range grasshoppers, the writer favors a combination of prevention together with the poisoning of rather large areas of our best range, even in bad outbreak years. It may appear to many readers that the above paragraphs contain impractical ideas and some unsupported assumptions. That is readily admitted. On the other hand the figures presented are as conservative as possible. Considering the immense importance of this problem at the present time, the state, together with whatever aid may be obtained from the federal government, should make a strenuous effort toward the control of range grasshoppers. It is by way of encouraging the most practical and intelligent solution of the problem that this duscussion has been presented.

## LOSSES FROM GRASSHOPPERS AND SAVINGS WHICH HAVE BEEN EFFECTED

Table 4 presents estimates for the past three years on the losses due to grasshopper depredations and the saving resulting from the employment of control measures. Had it not been for

TABLE 4.—LOSSES CAUSED BY GRASSHOPPERS IN MONTANA AND SAVING EFFECTED BY CONTROL MEASURES

| Year | Losses | | | Saving | |
|---|---|---|---|---|---|
| | Cultivated crops | Range | Total | Cultivated crops | Range |
| 1934 | $5,513,000 | $500,000 | $6,013,000 | $7,500,000 | —— |
| 1935 | 2,434,000 | 600,000 | 3,034,000 | 783,000 | —— |
| 1936 | 1,900,000 | 650.000 | 2,550,000 | 2,175,000 | —— |
| Total | $9,847,000 | $1,750,000 | $11,597,000 | $10,458,000 | |

the use of poisoned bait against these insects the total loss would have been over $22,000,000. The saving in 1934 was made mostly in north-central Montana where a good grain crop was grown in spite of the heaviest 'hopper infestation in the history of the state. The savings in 1935 and 1936 were made mostly in the irrigated sections.

### THE GRASSHOPPER SITUATION FOR 1937

In order to predict the probable extent of grasshopper infestations in 1937, adult and egg surveys were made during the latter part of August, September, and October, 1936. Approximately 250 examinations for adults were made in 43 counties and 247 examinations in 37 counties for grasshopper eggs. From the data collected, a summary of which appears in table 7, heavy infestations are to be expected in Park, Yellowstone, Big Horn, Petroleum, Lewis and Clark, Pondera, and Glacier counties. Moderate infestations can be looked for in all other counties east of the continental divide except Broadwater, Liberty, and McCone which are scheduled for fairly light outbreaks. Beaverhead and Meagher together with the counties west of the divide were not surveyed.

The survey on which the 1937 prediction is based was sup-

TABLE 5.—COMPARISON OF THE AMOUNT OF GRASSHOPPER BAIT ESTIMATED FOR 1937 WITH THE PREDICTED AND ACTUAL AMOUNTS FOR THE THREE PREVIOUS YEARS

| Year | No. counties surveyed | Poisoned Bait (Dry Basis) | | Acres to Poison | |
|---|---|---|---|---|---|
| | | Estimated from survey previous fall | Actually used | Estimated from survey previous fall | Actually treated |
| | | Tons | Tons | Acres | Acres |
| 1934 | 50 | 18,017 | 16,254 | 3,600,000 | 3,320,000 |
| 1935 | 52 | 3,073 | 1,595 | 600,000 | 315,000 |
| 1936 | 43 | 6,271 | 3,063 | 1,250,000 | 612,000 |
| 1937 | 43 | 7,759 | —— | 1,550,000 | —— |

ported by the United States Bureau of Entomology and Plant Quarantine, the Montana Agricultural Extension Service, and this office. Two men were employed for two and one-half months.

A comparison of the bait needed for 1937 in relation to that predicted and used in the three previous years can be obtained from table 5. In general the outlook for grasshoppers in 1937 is the most serious for any year since 1934. As mentioned in regard to the 1935 grasshopper work, the predictions are sometimes incorrect but, in spite of the errors which creep in, the survey method furnishes the most reliable information available. Attempting to cover such a vast area in a very limited time and with a reasonable expenditure of funds will necessarily result in some mistakes. The goodness of the predictions in 1935 and 1936 can be obtained from table 6 in which the amounts of bait predicted from the survey and the amounts actually used are given. Often such comparisons may be obscured by such factors as drought, delay in control operations, and lack of bait which will, of course, result in less bait being used. This is no reflection on the survey prediction. However, when far more bait was used than was predicted an out and out error in the survey is indicated. Twelve such mistakes were made in 1935 and five in 1936.

### THE MORMON CRICKET SITUATION, 1936-1937

Mormon crickets have been on the increase in Montana since 1931. In that year but a few hundred acres in southern Montana were infested. Today the overwintering eggs are in the soil to such an extent that over one million acres will be badly infested next spring and not long after hatching occurs the march of the cricket armies will begin. Sixteen counties are vitally concerned with this problem and two or three others to a less serious extent. In addition, 350,000 acres on the Tongue River and Crow Indian Reservation will be infested in 1937 unless a vigorous campaign of suppression is started early in the season.

Cricket control work for several years has been handicapped by not starting the work at a time when the best results could be obtained. In general, crickets hatch much earlier in the spring than grasshoppers. It is not unusual to have the young crickets

TABLE 6.—AMOUNTS OF GRASSHOPPER BAIT PREDICTED FROM SURVEY DATA AND AMOUNTS ACTUALLY USED IN 1935 AND 1936

| County | 1935 | | 1936 | |
|---|---|---|---|---|
| | Predicted | Used | Predicted | Used |
| | Tons | Tons | Tons | Tons |
| Beaverhead | 8.2 | 26.0 | 58.6 | 25.5 |
| Big Horn | 0 | 95.0 | 282.0 | 188.0 |
| Blaine | 108.0 | 25.0 | 180.3 | 15.0 |
| Carbon | 47.0 | 42.0 | 263.3 | 240.0 |
| Carter—Fallon | 0 | 4.0 | 226.6 | .8 |
| Cascade | 550.0 | 80.0 | 110.2 | 100.0 |
| Chouteau | 398.0 | 80.0 | 63.5 | 20.0 |
| Custer—Powder River | 14.0 | 47.0 | 292.9 | 24.0 |
| Daniels | 104.8 | 2.5 | 104.9 | 2.0 |
| Dawson | 0 | 5.0 | 159.6 | 4.0 |
| Fergus | 87.4 | 70.0 | 431.7 | 80.0 |
| Flathead | 12.0 | 0 | — | — |
| Gallatin | 71.7 | 8.7 | 79.7 | 84.0 |
| Garfield-Petroleum | 19.0 | 0 | 437.0 | 25.0 |
| Glacier | 24.6 | 1.0 | 34.1 | 20.0 |
| Hill | 228.0 | 19.0 | 224.0 | 26.0 |
| Judith Basin | 0 | 51.0 | 246.0 | 35.0 |
| Lake | 18.0 | .5 | — | 1.4 |
| Lewis and Clark—Broadwater | 45.2 | 11.5 | 6.3 | 24.9 |
| Liberty | 135.0 | — | 33.8 | — |
| McCone | 93.0 | 20.0 | 124.4 | — |
| Madison—Jefferson | 30.5 | 1.0 | — | 57.0 |
| Meagher | 14.0 | — | 22.0 | — |
| Missoula | — | — | — | .1 |
| Musselshell—Golden Valley | 13.5 | 90.0 | 130.5 | 25.3 |
| Park | 120.0 | 20.0 | 221.1 | 46.5 |
| Phillips | 0 | 25.0 | 51.2 | 25.5 |
| Pondera | 144.3 | 20.5 | 165.2 | 167.5 |
| Powell | 0 | — | — | — |
| Prairie | 0 | 47.0 | 61.9 | 7.0 |
| Ravalli | 0 | — | — | — |
| Richland | 0 | 19.0 | 210.1 | 30.0 |
| Roosevelt | 0 | 35.0 | 166.0 | 77.0 |
| Rosebud | 0 | 105.0 | 115.7 | 120.0 |
| Sanders | 6.4 | — | — | 3.5 |
| Sheridan | 91.0 | 41.0 | 375.1 | 65.0 |
| Stillwater | 40.0 | 130.5 | 389.4 | 60.0 |
| Sweet Grass | 80.3 | 87.5 | 121.8 | 380.0 |
| Teton | 269.0 | 45.0 | 150.6 | 190.0 |
| Toole | 49.0 | 26.0 | 21.6 | 100.0 |
| Treasure | 0 | 6.0 | 54.9 | — |
| Valley | 152.1 | 20.0 | 190.1 | 14.5 |
| Wheatland | 24.0 | 20.0 | 77.9 | 15.0 |
| Wibaux | 0 | 3.0 | 128.2 | 10.0 |
| Yellowstone | 75.0 | 170.2 | 257.2 | 750.0 |
| Totals | 3073.7 | 1594.9 | 6271.1 | 3063.65 |

appear in late March or early April. As the eggs are more or less concentrated in particular areas and as the young crickets up to the time they are half grown are more gregarious and thereby more susceptible to the dusting method of poisoning than later in the season, early efforts against them are paramount to success.

TABLE 7.—MONTANA GRASSHOPPER SURVEY (1936)
(Prediction for 1937)

| County | Infestation | | | Total crops | To be treated | Bait necessary | Cost |
|---|---|---|---|---|---|---|---|
| | Egg | Adult | Average | | | | |
| | Pct. | Pct. | Pct. | Acres | Acres | Tons | |
| Big Horn | 33.9 | 24.4 | 33.9 | 139,019 | 47,127 | 235.64 | $5891.00 |
| Blaine | 3.3 | 57.7 | 21.4 | 188,609 | 40,362 | 201.81 | 5045.25 |
| Broadwater | 3.3 | 14 | 6.9 | 38,073 | 2,627 | 13.14 | 328.50 |
| Carbon | 20 | 21 | 20.3 | 113,523 | 23,045 | 115.23 | 2280.75 |
| Carter | — | 13.1 | 13.1 | 79,810 | 10,455 | 52.28 | 1307.00 |
| Cascade | 15 | 30 | 20.0 | 208,922 | 41,784 | 208.92 | 5223.00 |
| Chouteau | 13.5 | 34 | 20.3 | 346,041 | 70,246 | 351.23 | 8780.75 |
| Custer | 28 | 32 | 29.3 | 85,838 | 25,151 | 125.76 | 3144.00 |
| Daniels | 5 | 56 | 22.0 | 222,422 | 48,933 | 244.67 | 6116.75 |
| Dawson | 25.5 | 15.9 | 25.5 | 219,041 | 55,855 | 279.28 | 6982.00 |
| Fallon | — | 25.6 | 25.6 | 149,652 | 38,310 | 191.55 | 4788.75 |
| Fergus | 16.1 | 53.5 | 28.6 | 359,999 | 102,960 | 514.80 | 12870.00 |
| Gallatin | 26.0 | 13.7 | 26.0 | 143,606 | 37,338 | 186.69 | 4667.25 |
| Garfield | 0 | 23.3 | 12.7 | 118,929 | 15,104 | 75.52 | 1888.00 |
| Glacier | 2.5 | 70 | 36.3 | 71,496 | 25,953 | 129.77 | 3244.25 |
| Golden Valley | — | 16.6 | 16.6 | 37,036 | 6,150 | 30.75 | 768.75 |
| Hill | 10 | 38 | 19.3 | 316,688 | 61,121 | 305.61 | 7640.25 |
| Jefferson | 25 | 18 | 25.0 | 34,451 | 7,407 | 37.04 | 926.00 |
| Judith Basin | 10 | 48.5 | 22.8 | 175,975 | 40,122 | 200.61 | 5015.25 |
| Lewis and Clark | 32.5 | 33.3 | 32.8 | 84,158 | 27,604 | 138.02 | 3450.50 |
| Liberty | 3 | 21 | 9.0 | 94,759 | 8,528 | 43.64 | 1066.00 |
| Madison | 26.6 | 27.5 | 26.9 | 103,852 | 27,936 | 139.68 | 3492.00 |
| McCone | 1.25 | 17 | 6.5 | 186,678 | 12,134 | 60.67 | 1516.75 |
| Musselshell | — | 13.5 | 13.5 | 52,698 | 7,114 | 35.57 | 889.25 |
| Park | 46 | 38.4 | 46.0 | 79,412 | 36,530 | 182.65 | 4566.25 |
| Petroleum | 5 | 61 | 33.0 | 40,376 | 13,324 | 66.62 | 1665.50 |
| Phillips | 7.6 | 37 | 17.4 | 187,776 | 32,673 | 163.37 | 4084.25 |
| Pondera | 31.4 | 69 | 43.9 | 175,830 | 77,189 | 385.95 | 9648.75 |
| Powder River | — | 27 | 27.0 | 126,654 | 34,196 | 170.98 | 4274.50 |
| Prairie | 39.4 | 29.1 | 39.4 | 105,607 | 41,609 | 208.05 | 5201.25 |
| Richland | 6.3 | 52 | 21.5 | 255,917 | 55,022 | 275.01 | 6877.75 |
| Roosevelt | 3.9 | 46.6 | 18.1 | 322,202 | 58,319 | 291.60 | 7290.00 |
| Rosebud | 24.3 | 12.0 | 24.3 | 96,602 | 23,474 | 117.37 | 2934.25 |
| Sheridan | 20.8 | 44 | 28.5 | 332,582 | 94,786 | 473.93 | 11848.25 |
| Stillwater | 19.1 | 29.5 | 22.6 | 122,982 | 27,794 | 138.97 | 3474.25 |
| Sweetgrass | 30 | 31 | 30.3 | 62,009 | 18,789 | 93.95 | 2348.75 |
| Teton | 23.3 | 29 | 25.2 | 209,343 | 52,754 | 263.77 | 6594.25 |
| Toole | 0 | 44 | 14.7 | 114,747 | 16,868 | 84.34 | 2108.50 |
| Treasure | 35 | 20 | 35.0 | 36,462 | 12,762 | 63.81 | 1595.25 |
| Valley | 18.9 | 38 | 25.3 | 282,563 | 71,488 | 357.44 | 8936.00 |
| Wheatland | — | 17.1 | 17.1 | 46,668 | 7,980 | 39.90 | 997.50 |
| Wibaux | 17.9 | 22.1 | 19.3 | 102,858 | 19,858 | 99.29 | 2482.25 |
| Yellowstone | 43.6 | 23 | 43.6 | 167,276 | 72,932 | 364.66 | 9116.50 |
| | | | | | | 7758.64 | $193,966.00 |
| | Total acreage involved | | | | 1,551,763 | | |
| | Tons of bait needed | | | | 7,758.64 | | |
| | Cost | | | | $193,966.00 | | |

Control work in early spring can be concentrated on about 10 per cent of the area which will otherwise be infested before the summer is over.

Seventeen WPA projects on cricket control were prepared in

this office in January, 1936, and forwarded to county commissioners for submission to the Works Progress Administration. Several of these were not submitted by the counties at all. Two were approved in May, and on June 5 five other counties were informed that cricket projects could be operated. Of the counties which attempted cricket control under WPA projects, Chouteau perhaps did the most work. The effort there got under way on June 22. Three seven-man crews dusted some 10,000 acres. This dusting was all done after the crickets had reached the adult stage and while it reduced crop damage to some extent action was too long delayed and too limited in extent to cut down the cricket population for another year. The same was true of other counties which operated WPA projects.

The damage from crickets in 1936 was in excess of $340,000 to cultivated crops and an unestablished amount to range areas. In table 8 are presented estimates for cricket control in 1937.

TABLE 8.—ESTIMATED COST OF CRICKET CONTROL FOR 1937

| County | Acres infested | Pct. to poison | Acres to poison | Total cost |
|---|---|---|---|---|
| Big Horn | 20,000 | 10 | 2,000 | $ 3,000.00 |
| Carbon | 90,000 | " | 9,000 | 13,500.00 |
| Cascade | 4,000 | " | 400 | 600.00 |
| Chouteau | 120,000 | " | 12,000 | 18,000.00 |
| Glacier | 5,000 | " | 500 | 750.00 |
| Judith Basin | 60,000 | " | 6,000 | 9,000.00 |
| Lake | 5,000 | " | 500 | 750.00 |
| Pondera | 10,000 | " | 1,000 | 1,500.00 |
| Park | 15,000 | " | 1,500 | 2,250.00 |
| Powder River | 20,000 | " | 2,000 | 3,000.00 |
| Rosebud | 220,000 | " | 22,000 | 33,000.00 |
| Sweet Grass | 30,000 | " | 3,000 | 4,500.00 |
| Stillwater | 15,000 | " | 1,500 | 2,250.00 |
| Treasure | 20,000 | " | 2,000 | 3,000.00 |
| Yellowstone | 25,000 | " | 2,500 | 3,750.00 |
| Wheatland | 20,000 | " | 2,000 | 3,000.00 |
| Tongue River I. R. | 50,000 | " | 5,000 | 7,500.00 |
| Crow I. R. | 300,000 | " | 30,000 | 45,000.00 |
| Total | 1,029,000 | | 102,900 | 154,350.00 |

## FINANCIAL SUPPORT FOR GRASSHOPPER AND CRICKET CONTROL IN MONTANA IN 1937

To protect cultivated crops in Montana from grasshoppers and crickets during 1937 and furnish very limited protection to range areas close to such cultivated crops, the costs will be about as follows:

| | | |
|---|---|---|
| For Grasshoppers | | |
| 6,559 tons of poisoned bait ($25.00) | $165,000.00 | |
| Operation of mixing stations, local transportation, etc. | 12,470.00 | |
| Labor, distribution of bait | none | |
| | | $177,470.00 |
| For Crickets | | |
| Poisoned dust | 38,587.00 | |
| Expense connected with operation of mixing stations, establishment of camps, camp equipment, local transportation | 24,940.00 | |
| Labor for dusting | 154,350.00 | |
| | | 217,877.00 |
| Total for both grasshoppers and crickets | | $395,347.00 |

There are 21 other states in the west and middle west with critical grasshopper situations. There are 7 states in the intermountain region facing cricket outbreaks. On October 23, 1936, representatives of the states interested in cricket control met at Pocatello, Idaho, to lay plans for the coming year. None of these representatives was in favor of attempting another cricket campaign as a Works Progress Administration project. Reasons for this are many, but in brief cricket-control work is not a suitable project for WPA. Crickets must be dusted early in the morning and in the evening. The hours of labor are thus very irregular as are the times of day when the work must be done. It is very desirable therefore, if not almost essential, for the men to live in camps close to the field of operations. Sentiment at this meeting was strongly in favor of a cooperative arrangement between the federal government (Bureau of Entomology and Plant Quarantine, United States Department of Agriculture) and infested counties. It was proposed that the federal government furnish the labor necessary for applying the dust and the counties provide the materials and take care of the expense incident to the establishment of camps. The maintenance of the camps would be paid from the daily wage of the men occupying them. Under such an arrangement farmers as well as men from relief rolls could be engaged in the work thereby providing enough local men to create a strong sense of responsibility in handling the poisonous materials. Furthermore by paying a reasonable wage the work could be done at

the most opportune time. The division of costs would be three-fifths federal government and two-fifths county.

Following the cricket meeting in Pocatello, the entomologists of 22 western and middle western states, together with many of the commissioners of agriculture of those states, met at Omaha, Nebraska, on December 4-5, 1936, to consider the 1937 grasshopper work. The proposal was made that the Congress of the United States create a fund of $5,000,000 to be administered by the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture and used to finance control operations against *insects of regional importance*, such as grasshoppers, chinch bugs, etc. Each succeeding congress would be asked to replenish this fund to its original amount. During some years none of this fund would be used. Decision relative to the species of insects against which the fund could be employed would rest with a technical committee appointed by the Secretary of Agriculture. The plan has rather wide support and is very likely to be adopted. Its chief merit is that it would make possible timely and concerted action against insects which affect whole agricultural regions. It would place the work on a sound basis instead of putting the control of such insects on an emergency basis, often with appropriations of money made too late in the year to give effective control.

If this plan receives favorable action by congress, money would be available for the control of both grasshoppers and crickets. However, to be of much value for cricket control in 1937, the measure would have to pass congress by March 15 to April 1 at the latest. With some doubt as to this possibility, the intermountain states are asking a special appropriation for cricket control should it become evident that the $5,000,000 fund will be delayed. In case a special cricket appropriation is obtained, the suggested cooperative arrangement between the federal government and the counties would likely hold; if the larger fund is released in time for crickets that will not be the case. Certain commitments by counties will undoubtedly be required, however, such as the cost of operating mixing stations and local transportation in the case of both grasshoppers and crickets, and the additional cost for the establishment of camps in the case of crickets.

*State Support.*—At a meeting of farmers, stockmen, county commissioners and others interested in insect control held at Billings on December 9, 1936, it was voted to ask the State of Montana to share with the counties the cost of the work against grasshoppers and crickets. As indicated in the paragraphs above even with the federal government aiding very greatly by furnishing materials, labor, and transportation of materials to central points, there are certain expenses which must be met by counties. If federal money is available for cricket control in 1937 the county expense will be rather high. It is thus proposed that the state make an appropriation, available July 1, 1937 and a like sum on July 1, 1938 to reimburse the counties on a two-thirds state one-third county division. Should the sum be inadequate to meet this requirement, then the state money would be pro-rated to the counties in accordance with their insect-campaign expenses.

If the $5,000,000 fund is passed by congress in time to take care of cricket control as well as grasshoppers, the expense to be met by all the counties will be approximately $37,410. If the fund goes through early enough to take care of grasshoppers only and a special federal appropriation for crickets is made on a county-cooperation basis, the total expense for all the counties will be greater, namely about $75,997.

## IMPORTANT INSECTS OF THE YEARS 1935-1936

### THE PALE WESTERN CUTWORM

The abundance of pale western cutworms *(Agrotis orthogonia* Morr.*)* is closely related to rainfall. When the May and June rainfall is low, conditions are favorable to cutworm increase. With two consecutive seasons of low rainfall (less than 3 inches) in May and June, a great increase in this cutworm may be expected. Twelve counties (Teton, Pondera, Glacier, Toole, Liberty, Hill, Chouteau, Blaine, Phillips, Valley, Fergus, and Cascade) are facing such a situation in 1937. More damage to grain crops was done in some of these counties in 1936 by pale western cutworm than for many years, with the possible exception of 1932. As soon as rainfall data were avilable last summer a warning was sent out relative to the danger of cultivating summer fallow in the above areas during the period of August 15 to September 15. Cultivation or seeding operations at that time breaks the slight crust which has been formed by any light rains and makes the soil very attractive to the female moths for depositing their eggs.

So far as winter wheat is concerned, the die is cast. The eggs have been laid and next spring they will hatch into young cutworms. More or less the same condition is true of land on which spring wheat or other grain is to be seeded. If cutworms are going to be present next season on that land, the eggs are already present. There is this difference, however. In Alberta it has been found that the very young larvae cannot withstand starvation. After the eggs hatch the young worms must have some green food or they die. This offers some hope and suggests the possibility that if the land is not seeded for a few days following its thorough preparation for seeding, many of the insects may be starved out. The effectiveness of such an attempt at control would depend on knowing when the eggs hatch. An effort will be made this coming spring to give farmers in the threatened region this information.

### SAY'S PLANT BUG

Say's Plant Bug was not so noticeable in 1936 on account of the reduction of wheat by drought and grasshoppers. Nevertheless they were numerous over the north-central area in

which damage has been reported for the past four years. A new occurrence was found in irrigated wheat at Malta. A field laboratory was established at Big Sandy and observations made during the summer months. Weedy fields provide the principal hibernation quarters. The first eggs appeared in May and until October there were only about two weeks when egg laying was not observed. The peak of the second generation egg laying was in July. The average number of eggs in each of several hundred egg masses was 30, and hatching occurred in from 4 to 7 days, depending on the temperature. Humidity apparently had little effect on hatching. The chalcid egg parasite, *Telelonomous ashmeadi*, was numerous. While some egg masses were parasitized 100 per cent, the total parasitism of eggs collected in the field was only 10 per cent. A small Melyrid beetle, *Cololps bipunctatus*, was numerous and an active predator on the eggs but its actual control value is doubtful. Three species of adult parasites were reared from field collected bugs. These are the tachinid flies, *Gymnosoma fuliginosa*, *Cylindromyia armata*, and *Senotainia vigilans*. The latter two have not hitherto been reported as parasites of Say's plant bug. Many of the adult parasites overwinter as pupae in the hibernating host. Adult parasitism of field collected bugs was 11.7 per cent.

Spring burning of weeds and trash in infested fields, idle lands, and weedy roadsides appears to be the only method of controlling Say's Plant Bug.

### THE BEET WEBWORM

Beet webworms (see figure 3) appeared in great numbers in 1936 for the first time since the unprecedented outbreak of 1932. There are usually two full generations of this insect in Montana. The moths which develop from overwintering larvae appear in May and early June, their eggs producing the first generation of worms in late June and the first part of July. Moths from the first generation of webworms occur late in July and lay eggs for a second generation of worms in August. It is the first generation of webworms which causes by far the greatest amount of damage to field beets, gardens, alfalfa, peas, etc.

**First Generation, 1936**

The moth flight was light in most of the Yellowstone Valley, and in Jefferson, Gallatin, Glacier, Toole, Flathead, Lake, Ravalli, and Beaverhead counties.

Moderate flights appeared in Rosebud, Custer, Prairie, Dawson, Richland, Broadwater, Lewis and Clark, and Teton counties.

Heavy flights of moths were present in Sweet Grass, Fergus, Judith Basin, Cascade, Blaine, Phillips, and Valley counties.

Webworms appeared throughout all the above-named counties but the heaviest, though spotted, outbreaks occurred in Blaine, Custer, Sweet Grass, Gallatin, Jefferson, Silver Bow, Beaverhead, and Lake counties.

Extensive spraying for webworms was carried out in Blaine, Richland, and Yellowstone counties. Intensive work had to be done in the vicinity of Butte to prevent migrations into the city where dwelling houses were being invaded with the worms. Practically all the green vegetation with the exception of cotton-

Figure 3.—The sugar-beet webworm, (*Loxostege sticticalis* L.) greatly enlarged.

wood trees was attacked. This migration could have been completely checked if the worms had been discovered before they left the weedy patches out on the flat where they developed and from which the migrations started.

The greatest losses to sugar beets occurred in the vicinity of Chinook and Harlem. In these areas the worms got into the fields when the beets were only 2 or 3 inches high and not large enough to get the proper effects from spraying. Some fields were completely destroyed when they were invaded early. Part of this unseasonal attack was the result of drought which prevented the growth in waste places of the early food plants (Russian thistle and pigweed), thus causing the very young worms to migrate to the young beets. Usually the migration does not occur until the beets are much larger. Heavy damage to beets was suffered also on the lower Yellowstone.

In sections of Pondera and Phillips counties about 90 per cent of the female moths were sterile so practically no eggs were laid.

**Second Generation, 1936**

A heavy flight of moths was observed over practically the entire state but, with the exception of the Triangle Area, a high percentage of them was sterile, resulting in a very light second generation of worms. Fergus, Judith Basin, and Blaine counties had second generation webworms in small numbers.

The beet webworm since 1934 has been made the subject of an exhaustive study by the Montana Agricultural Experiment Station. Particular attention is being paid to improved methods of control, to the possibilities of accurately forecasting outbreaks, and to certain physiological and ecological factors which are important from the control standpoint.

### BLISTER BEETLES

A scourge to field beets, potatoes, gardens, and ornamentals during 1935 and 1936, were various species of blister beetles with the spotted blister beetle *(Epicauta maculata* Say) predominant. Thousands of acres of beets were lost because of these insects and more damage would have resulted had not arsenical sprays and dusts been employed. A rise in the number of blister beetles always accompanies years of grasshopper abundance because, in the larval stage, the blister beetles feed on grasshopper eggs.

### THE FALSE CHINCH BUG

In point of numbers this small insect, a close relative to the true chinch bug, was the greatest pest in irrigated sections of Montana in 1936. In the lower Yellowstone country potatoes were severely injured and often stunted to the point of crop failure by heavy swarms of these tiny insects. The wingless nymphs swarmed into cultivated fields from surrounding grass ands where they went through the first part of their development. The drought forced greater numbers to migrate to irrigated crops and must as well have been very favorable to the production of the species. Potatoes and gardens suffered the most. Corn seemed to recover from what at first appeared to be rather serious injury.

**FRUIT INSECTS**

The Flathead Valley cherry orchards have several insect pest problems. Chief among these is the black cherry aphid *(Myzus cerasi* Fab.*)* which sucks sap from the leaves of the succulunt terminal growth, causing the terminals to become misshapen. On young trees this is particularly undesirable and all of the Flathead cherry orchards consist of young trees. Practically 100 per cent of the Flathead sweet cherry trees were killed in the unseasonal freeze of October, 1935, but the majority of the growers will have their orchards replanted by 1937 or 1938. The cherry aphid problem will then become acute unless control measures are carried out.

Field tests during the 1935 season showed that the cherry aphid could be controlled nearly 100 per cent with a single spray application. The best spray formula proved to be a summer spray oil 2½ gallons, water to make 100 gallons, and nicotine sulphate (Black Leaf 40) ¾ pint. This was applied after the buds had swollen and showed green on the tips and just as they began to open. (See figure 4).

Cherry growers are still somewhat skeptical of controlling the black cherry aphid by spraying. This is occasioned by improper spraying in the past. There is little or no chance of controlling the aphids after the leaves have curled. The aphids migrate from the cherry trees late in summer after their damage is done and this fact often gives the grower the idea that a late season spray killed them, as numerous cast skins are left behind. The spray must be applied early in the spring after the eggs have hatched and before the aphids can seek cover on the trees, for the spray must come in direct contact with their bodies. The entire tree must be drenched with the spray regardless of the amount which falls to the ground as waste. High pressure machines are essential to force the spray into crevices of the tree where aphids may be seeking shelter. Probably the only way to convince the cherry grower of the efficiency of this procedure is to conduct spraying demonstrations in representative orchards in each district.

The cherry fruit fly *(Rhagoletis fausta* O. S.*)* is apt to be relegated to minor importance until the cherry orchards come into bearing again. It is much more than a "scare" as indicated in the last State Entomologist Report. Sour cherry orchards

unsprayed for two seasons yielded 40 per cent wormy cherries in the 1935 season. Maggots were found in sweet cherries in several locations near sour cherry trees. In one sour cherry orchard where control measures have been in force for four seasons the infestation remains at a fraction of 1 per cent and

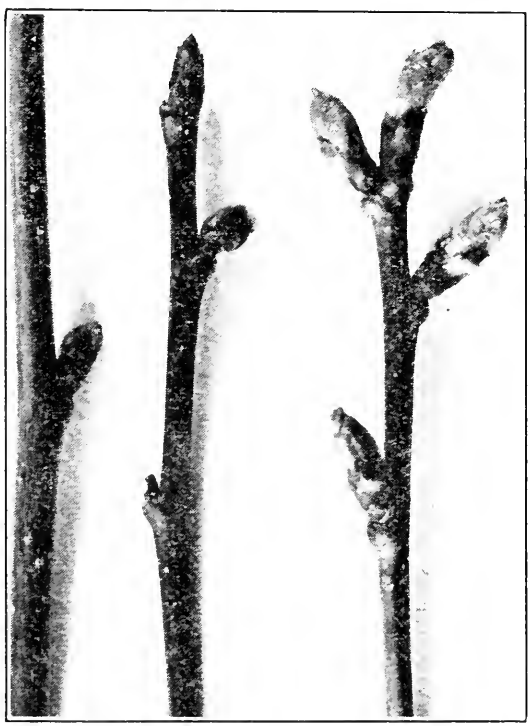

Figure 4.—Sweet cherry buds in different stages of development. The correct time for applying the spray for the black cherry aphid is shown in the twig to the right.

no worms occur in sweet varieties. It is not desirable to eradicate sour cherry trees, the preferred hosts, but rather use them as a trap crop and thus keep the fly population down. The flies also propagate in wild pin cherries, the original host.

Observations over the past four seasons indicate that in odd years a much larger number of fruit flies emerge than

during even years. In 1933 many maggots were reported, in 1934 very few flies or maggots were found, in 1935 quite a number of flies were taken and many maggots found, then again in 1936 fly and maggot populations were very low. It is safe to predict that in 1937 cherry fruit flies will be numerous around sour and wild cherries, but not in sweet varieties as the new trees will not be bearing.

A golden opportunity is afforded during the next three seasons to practically eliminate the cherry fruit fly as a pest of the Flathead cherry industry before the sweet cherry trees come into bearing. This can be accomplished, first, by eradicating all wild pin cherry trees near orchards, or spraying them, and second, by spraying all sour cherry trees. Tests during 1934, 1935, and 1936 have shown the efficiency of lead arsenate spray in reducing infestations. Lead arsenate ½ pound in 10 gallons of water sprayed in coarse drops with low pressure about one quart per tree is the recommended practice. This is usually applied twice, a week apart, the first when the fruit is just showing color. The exact time depends on the appearance of the flies.

The codling moth *(Carpocapsa pomonella* L.*)* is very troublesome to Montana apple growers. Only one brood appears in a single season but is spread over most of the season. This factor combined with rather indifferent spraying practices has brought about severe apple losses in a number of places. A carefully applied calyx spray followed by two cover sprays, properly timed by the weather and emergence of moths, gives satisfactory control. Lead arsenate 3 pounds to 100 gallons of water plus 1 pound of spreader remains the standard formula. This pest has not as yet reached all Montana apple trees. This past season it was reported for the first time in Ronan. It is especially bad in towns where back yard trees are not properly sprayed.

The Oyster-shell scale *(Lepidosaphes ulmi* L.*)* warrants consideration as it is so prevalent on apple trees. Tests during 1935 and 1936 of various spray materials showed that liquid lime sulphur 28-32° Baume at 1 gallon to 8 gallons of water applied as a dormant spray, gave the best control. Where apple scap sprays of liquid lime sulphur 1 to 25 have been used regularly, oyster-shell scale has not become a pest. Dry lime sulphur and

dormant summer spray oils should be used only in the event liquid lime sulphur cannot be obtained, as they appear to be less efficient under Montana conditions.

Yellow Jackets *(Vespidae)* appear in cycles. In 1933 apparently there were none. In 1934 there were quite a number but they appeared too late to damage the fruit crop appreciably. The season of 1935 saw considerable damage to the cherry and berry crops by yellow jackets. Early in 1936 "queen" yellow jackets were numerous. As the season advanced these ceased to appear, which is normal, but "worker" yellow jackets failed to appear in their place as is usual, only an occasional one being seen all season.

Undoubtedly there is some natural force which checks the yellow jackets after they have increased over a three-year period. In 1935 a few tests with fly traps and poisoned baits established the fact that they preferred ground meat, such as liver, to fermented fruit or fresh fruit, such as cherries. This factor might be used in drawing them away from feeding on ripe berries or cherries. Sodium arsenite failed to function as a poison as it repelled the wasps from the bait. Baghouse arsenic baits gave a high per cent of kill. Considering all angles the poisoned bait or fly trap is much too slow a procedure for wasp control once they start attacking the fruit.

**Other Orchard Insects**

New orchards, especially those planted on newly cleared land, are often seriously defoliated by a number of species of leaf-feeding insects. Probably the most important of these are the pear and cherry slug *(Eriocampoides limacina* Retz.), and other undetermined slug feeding on cherry leaves, both of which made their appearance for the first time in the Flathead Valley this year. The former attacks the upper surface of the leaf, is very dark green, enlarged at the head end and holds the tail end up from the surface of the leaf. The latter (figure 5) attacks the lower surface of the leaf, is very pale green, tapers from head to tail, and does not hold the tail end erect. Tests during 1935 gave nearly 100 per cent control with contact sprays and dusts, stomach poison sprays and dusts, and hydrated lime as a dust. Even ordinary road dust gave 75 per cent control. With this evidence a slug infestation appears to be caused chiefly by neglect or lack of knowledge on the part of the orcharist.

A number of species of caterpillars have been found on the leaves of the young trees. No one species is numerous enough to demand attention but the combined feeding of these forms is a serious drain on the vitality of the growing trees. A covering of lead arsenate spray 2 pounds to 100 gallons of water plus 1 pound of spreader applied after the trees came into full leaf would check most of this damage. The feeding is confined largely to the mature leaves rather than the growing tips. This

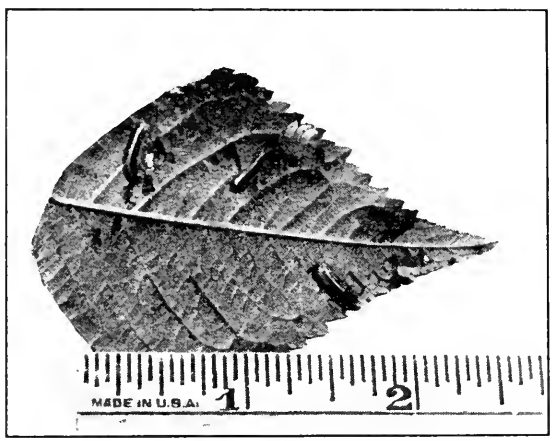


Figure 5.—Larvae of the cherry saw-fly.

spray would also take care of the slugs although a second application would probably be needed in late July or August for the second brood of slugs.

Old orchards suffer somewhat from the same insects but where sprays for codling moth are applied they ceased to be of importance on apple trees. Cherry fruit-fly sprays are an aid to old cherry trees in this respect.

### SMALL FRUIT INSECTS

The Strawberry Root Weevil *(Brachyrhinus ovatus* L.*)* is the major insect pest of western Montana strawberries. In the grub stage it attacks the roots and crowns of the plants. The adult beetles feed on the leaves and fruit. A cultural program allowing the berry plants to grow only two seasons, plowing them under in the fall of the second season, and growing a cover

crop the following season is a distinct aid in control. The best method of checking this insect is by the use of a poisoned bait. This is placed in the crown of the plants at the rate of about 50 pounds to the acre. Tests of a number of bait formulae recommended by other workers showed poisoned, ground dried-apple bait to be superior in attracting the weevils and in killing them. A formula devised in Montana employing half bran in the bait made it much cheaper and just as effective. The bait consists of 10 per cent by weight of baghouse arsenic, 45 per cent of bran, and 45 per cent of dried apple. Grinding the dried apple by power or in a meat chopper is much easier if the bran is ground with it. Water is added to make a crumbly mass of the bait. It should be applied in the spring when the overwintering weevils appear, usually in April, and again later in the summer when the newly emerged weevils appear, about the last of June or early in July. Strawberry growers generally do not realize what is killing their plants and of course do not know how to control this pest. Nearly every strawberry grower in western Montana is confronted with this pest and needs to be advised of means of control. At present the dried apple bait for strawberry root weevils is covered by a patent so growers are subject to an infringement suit if they use it. However, growers in other Pacific northwest states make their own dried apple bait and no suit has ever been brought against a grower.

The strawberry leaf roller *(Ancylis comptana* Frohl.*)* is common in western Montana but usually does not develop in damaging numbers. Last season, however, in a few places through lack of information, it had developed to a serious pest. It was readily demonstrated that a lead arsenate spray 1 pound to 50 gallons of water applied before the leaves had rolled was effective in reducing the numbers. Contact sprays of oil and nicotine and nicotine and soap also gave satisfactory results. This latter might be used when there is danger of poisoning the fruit. Two applications of spray are needed, applied before the development of each crop of berries. Again high pressure spraying is essential to thoroughly coat the foliage.

The raspberry sawfly *(Monophadnoides rubi* Harris*)* appeared in harmful numbers in several locations in western Montana last year. The immature form of the sawfly looks like a many-legged, fuzzy, green caterpillar. In feeding it eats out

all of the leaf tissues leaving just the leaf ribs. The application of a lead arsenate spray 1 pound to 50 gallons of water in late April or early May, depending on the season, would give effective control. Annual spraying is not essential. It is safe to advise spraying only following seasons of severe infestation, or when the lower leaves of the plant exhibit many fine holes from feeding by the young worms early in the season.

### THE FOREST TENT CATERPILLAR

The most conspicuous insect on shade trees in 1936 was the forest tent caterpillar *(Malacosoma disstria* Hbn.*)* Along the upper Yellowstone and particularly in Livingston's Island Park, cottonwood trees were completely defoliated by these insects. Of the hundreds of trees in that park only one was noticed which had been overlooked by the caterpillars. The trees sent out new growth during the latter part of the summer and probably suffered no permanent injury but the appearance and usefulness of the park up to July was ruined. In the case of such tall trees control is difficult if not impossible without proper equipment for dusting or spraying the foliage rather early in the season while the caterpillars are still small. At that time they are easily killed by arsenicals.

This species does not build a tent like its close relative the apple tree tent caterpillar and for that reason has been named the "tentless" tent caterpillar. The larvae instead of hiding away in a tent congregate in great masses in the crotches of the branches. They are about two inches long when full grown and are a dusky brown in color with fine yellowish-brown stripes on the back and sides. They are covered with long fine brown hairs. There is but a single brood. Pupation occurs in a silken cocoon attached to any convenient place on the trees or nearby objects. The adult moths vary in color from reddish to fawn, the males being smaller and much darker than the females. They emerge from the cocoons in midsummer and the females deposit their eggs in rings around the smaller twigs. The eggs develop into young caterpillars by fall but the young worms do not leave the egg shell until the following spring when the leaves begin to unfurl.

### VIRGINIA CREEPER LEAFHOPPER

*Erythroneura comes zic-zac* Walsh

The attention of the State Entomologist's office was first drawn to this insect in August of 1907, when specimens and injured foliage were received from Billings. It was not until 1926 that injury was again reported, this time from Glasgow. Garfield, Rosebud, Custer, and Powder River counties reported

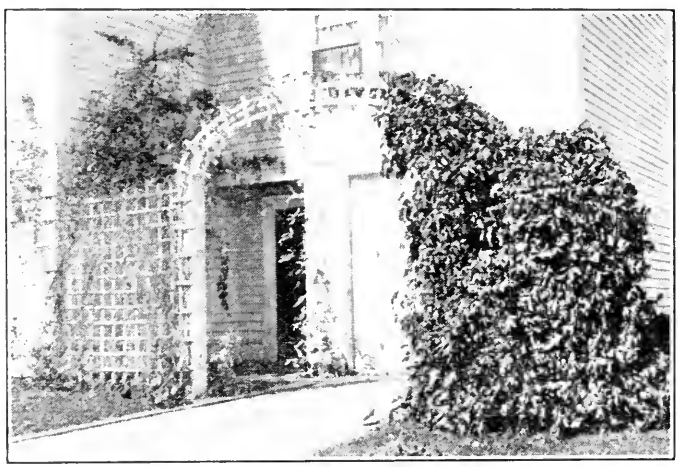

Figure 6.—That part of the vine to the right was protected from the Virginia creeper leafhopper by a single spray; the vines to the left were unsprayed.

it in 1928, Park and Lewis and Clark counties in 1929, Prairie County in 1930, and Dawson County in 1931. It has up to the present time been reported from or observed in all parts of the state except the extreme west and the northwestern corner.

The Virginia Creeper leafhopper is a minute, elongate, pale yellow insect with a conspicuous rusty-brown zig-zagging stripe on each wing. It sucks the juices from the leaves, giving them a gray, mottled appearance. When the pests are abundant the leaves are so injured that they drop from the vines.

The biology and control of this insect have been studied at Bozeman, and control experiments were quite successfull. The

leafhopper hibernates as an adult, flying in the spring to the vines where it lays its eggs within the leaf tissue. When these eggs hatch the nymphs join the adults in their depredations. At Bozeman there is apparently one complete generation and a partial second.

The best control was obtained by spraying the vines shortly after the first nymphs became noticeable on the under sides of the leaves. Treatment before this time did not give satisfactory results, and spraying after this period was too late to prevent considerable injury. If the leaf hoppers are abundant, though, spraying is advisable at any time during the summer.

While community action against these insects is no doubt desirable, that it is not essential can be seen from figure 6. This shows how a part of a large Virginia creeper was protected by one application of spray. The picture was taken in September and the part of the vine to the left has been completely defoliated. The sprayed portion is still green.

The greatest degree of control was obtained with the following mixture:

1 2/3 ounces nicotine (Black Leaf 40)
8 ounces summer oil emulsion
5 gallons water

The oil should be placed in a suitable container and the water added slowly and with continuous agitation until a uniform milky emulsion is obtained. The nicotine is thoroughly mixed with the emulsion just before the spray mixture is to be applied. Its effect is rapidly lost if the mixture is allowed to stand for any length of time.

If a summer oil is not available it may be made as follows:

To one part of skimmed milk add *very slowly* two parts of a good grade No. 10 viscosity lubricating oil such as may be purchased at any filling station. The mixture must be thoroughly agitated all the while that the oil is being added. An electric kitchen mixer or a common egg-beater may be used for this purpose. If properly made, the resulting emulsion is heavy and white with no evidence of free oil.

The spray mixture should be liberallly applied to both sides of the vines if possible. The under sides of the leaves should be

thoroughly drenched as the success of the treatment depends largely upon the thorough wetting of all of the foliage.

### ALPINE ROCK CRAWLER

*Grylloblatta campodeiformis* Walker

This rare alpine insect (figure 7) was discovered for the first time in Montana during September, 1936. It has been collected previously at a few points in the northern Rocky Mountains, as far north as Banff, Alberta, and now as far south as southern Gallatin County, Montana, although we are by no means certain that these points represent the extremities of its range.

The physical requirements of this insect are interesting in that its normal range of activity lies between 32° F. and 60°F., with an optimum indicated at about 38°F. It cannot survive 80° F., a temperature at which the most of our summer insects are active.

While this insect is too rare and too limited in its habitat to be of economic importance, it is likely that its primitive nature will allow rather definite deductions to be drawn as to the relationships of many of our present-day destructive insects.

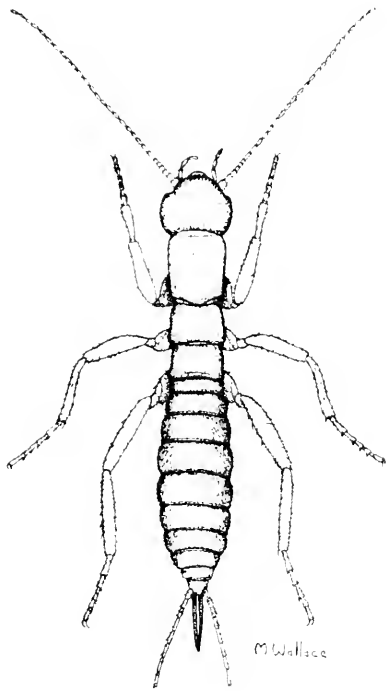


Figure 7.—Gryoblatta, a rare and primitive alpine insect collected for the first time in Montana in 1936.

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